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The impact of high-speed railway on tourism spatial structures between two adjoining metropolitan cities in China: Beijing and Tianjin

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ABSTRACT

This study examines the impact of HSR services on the tourism spatial interactions between Beijing and Tianjin in China. Data were collected from official statistical reports. A method of derivation was developed and several indexes, such as tourism mean center, and tourism standard distance are further applied to measure temporal-spatial changes between the two adjoining cities. The results reveal the dynamic tourism spatial interaction between Beijing and Tianjin has been influenced by a range of factors including population, destination attractiveness, disposable income and income elasticity, changes in the domestic and international spatial structure of tourist flows and how destination management organizations react to the changes. The study has implications for both the research and practice of city transportation and tourism development.

1. Introduction

In recent years China has undergone a period of rapid High Speed Rail (HSR) construction and now has the world's largest HSR network (Wang et al., 2018; Yang et al., 2019). By the end of 2017, China's HSR network had grown to 25,000 km (China Ministry of Transport, 2018) and is planned to increase to 30,000 km by 2020 (China Ministry of Transport, 2017). It is expected that the temporal and spatial changes facilitated by the HSR system (Chen, 2019) will both booster domestic tourism flows and generate significant changes in the structure of tourism flows (Yin et al., 2019). Theoretically, the compression of travel time and space induced by short-distance HSR services provides opportunities for adjoining cities to be regarded as the "same city". In practice, however, adjoining cities tend to operate independently, and each can be expected to adopt strategies that will increase its competitiveness vis à vis the other city. Understanding the current spatial relationship between adjacent cities and the impact potential impact of HSR has important implications in relation to collaboration on tourism policy development and planning.

Previous studies have examined HSR's impacts on regional medium-sized cities in France and Spain (Bazin et al., 2006; Coronado et al., 2013; Ureña et al., 2009), on metropolitan cities including Madrid, Paris, and Rome (Delaplace et al., 2014; Garmendia et al., 2012; Pagliara et al., 2015), on the intermediate areas between major metropolitan areas (Vickerman, 2015), and on cities along HSR routes (Chen and Haynes, 2015; Wang et al., 2012; Wang et al., 2014b; Yan et al., 2014). Empirical studies conducted in China show that there has been an increase in accessibility of all cities and regions along HSR lines (Liu and Zhang, 2018). Research has also found that regional economic disparity has decreased since the introduction of HSR (Chen and Haynes, 2017), with the exception of a number of central-Eastern cities where there is some evidence that they might gained greater accessibility benefits from HSR than other regions (Cao et al., 2013). HSR promotes wider destination choice, which can create significant changes in the spatial distribution of tourism resources (Wang et al., 2012).

Despite the growing research interest in the effects of HSR, the impact of HSR on the temporal-spatial pattern of tourism flows between adjoining city pairs remain unexplored. This study aims to contribute to the transport and tourism literatures by addressing this gap by assessing the impact of high-speed railway on tourism spatial structures between two adjoining metropolitan cities. We chose Beijing and Tianjin for this study based on the size of the two cities, their adjacent location, well-developed tourism infrastructure, and the length of time that HSR has been operating (Wang et al., 2018). Specifically, this study attempts to understand: a) the impact that HSR can have on the dynamics of tourism spatial interaction between Beijing and Tianjin; b) the changes in spatial structure of both international and domestic tourist flows between the city pair. In addition, we also examine how each city responded to the impacts of HSR in its tourism development and

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marketing policies, as evidenced by the impact of high-speed rail on tourism spatial structure.

2. Literature review

Transportation is an essential component of tourism infrastructure (Wang et al., 2018). In general, tourism demand is negatively related to distance, i.e. the longer the distance, the smaller the demand. This is the so-called "distance-decay effect" (Bull, 1991). Geographic distance is invariable, but travel time can be reduced with the introduction of new transportation technology thus stimulating tourism demand. In addition, reduced travel time enables tourists to spend more time enjoying tourism activities at a destination. Travel time thus replaces distance as a determinant of tourist demand in the gravity model, widely used to investigate interaction between spaces (Gu and Pang, 2008; Prideaux, 2000). The result is time-space compression known as the "time compression effect" of HSR (Wang et al., 2018). The "time compression effect" also provides destinations connected to the HSR network with the opportunity to grow the level of tourist arrivals to that destination (Zhou and Li, 2018).

The opening of a HSR will increase accessibility in general (Ravazzoli et al., 2017) and can will disrupt regional spatial structures (Wang et al., 2018) to the extent that there may be both winner and loser cities (Fröidh, 2005; Wang et al., 2019). Chen and Haynes (2015) found significant positive effects of HSR on accessibility as well as economic convergence in several regions of China. Similarly, Liu and Zhang (2018) further confirmed that HSR the increased accessibility and reported a reduction of access disparity within regions but not between regions. Examining the potential HSR in the Piedmont Atlantic Megaregion in the US, Yu and Fan (2018) estimate how HSR will improve the megaregional accessibility but they also predicted an increase of inequality in accessibility. In the UK, Fröidh (2005) suggested that while the building of HSR will disrupt the country's geography, it may not provide significant overall accessibility benefits. Vickerman (2015) for example found that cross-border inter-regional HSR services such as Europe's Trans-European Transport Network initiative has failed to reduce regional disparities in accessibility or to integrate regions across national borders in many regions.

HSR may also generate changes in the spatial distribution of industry (Chen and Hall, 2011). A study by Gimpel (1993) found that France's TGV network has played an important role in changing the socio-economic and spatial patterns in the regions it services. Plassard (1991) observed that a centralizing effect occurred in France where Paris has become the center of the star-shaped TGV network. Masson and Petiot (2009) noted that after the introduction of HSR between Paris and Marseille in 2001 there was an increase in short stay travel to Marseille and as well as a change in travel by specific market sectors such as seniors and international travelers. However, the introduction of HSR does not automatically lead to increased tourist flows. The construction of a HSR line from Perpignan in southern France to Spain generated increased flows of French visitors to Spain but not of French visitors to Perpignan (Masson and Petiot, 2009), because French tourists were more attracted to Spanish cities such as Barcelona than Perpignan.

HSR can also trigger tourism spatial competition between linked cities, as in the case of Perpignan and Barcelona (Masson and Petiot, 2009). In response to the changes brought by HSR, destinations may develop policies to differentiate their tourism appeal through marketing and the introduction of new products (Chen and Hall, 2011; Masson and Petiot, 2009). A "structuring effect" occurs where the introduction of a new transport system assists local actors to maximize the utility of pre-existing structures and relationships or encourages policy makers to adopt complimentary policies that utilize HSR as a change agent (Masson and Petiot, 2009).

HSR may also facilite changes in the spatial structure of regional urban tourism, offering favorable conditions for regional tourism cooperation and stimulating integration and aglormeation of urban resources (Wang et al., 2018). For example, Liang (2010) reported a pattern of cooperation among a number of Chinese cities including Guangzhou, Changsha, and Wuhan. Zhou and Li (2018) observed a similar patten with the Wuhan-Guangzhou HSR that has helped optimize the opportunities for tourism co-operation between cities within the Delta area including offering multi-destination itinerates using the savings in time achieved by using HSR. Using economic relation model and spatial analysis of 338 cities across China, Wang et al. (2018) presented a tourism spatial structure with 19 urban agglomerations. Recently, Huang et al. (2019) have shown that the influence of HSR on the urban agglomeration tourism system is increasing.

The development of HSR systems also stimulates inter-city travel (Hou et al., 2011). HSR attracts travelers who previously used other transport modes leading to changes in travel behavior (Fröidh, 2005). Since the opening of Beijing-Tianjin HSR in 2008, inter-city commuting traffic has increased with commuters working in Beijing and living in Tianjin. In this way HSR can influence commuters' space feeling, facilitating a life-style based on inter-city commuting (Hou et al., 2011). Zhang et al. (2013) examined HSR's impact on urban tourism in Nanjing and found that HSR expands tourists' route choice, range and frequency of visits, but tourist stay time may be reduced. However, little is known about the impact of HSR on the change of inter-city tourism spatial structures.

3. Methodology

3.1. Research context

The area around Beijing and Tianjin (the Jingjin Region, Fig. 1) has experienced rapid development in recent decades and is one of the most heavily urbanized region in China. Prior to the opening of the Beijing to Tianjin HSR service in 2008 the region suffered significant passenger congestion. Prior to 2007, the average speed of the rail service connecting Beijing and Tianjin was 98–110 km per hour, and the travel time was about 2 h. In April 2007, the average speed was increased to 200 km per hour with a travel time of 69 min. The introduction of HSR services in 2008 led to a decrease in travel time to 34 min. The designed speed of the HSR service is 350 km/h although the commercial speed is limited to 300 km/h during normal service (see Table 1).

Construction of the Beijing to Tianjin HSR commenced in 2005 and was completed in August 2008 with a total length of 113.54 km. The line passes through the directly governed city regions of Beijing and Tianjin with no stops (See Fig. 1). By the end of the first full 12 months of operation, the Beijing-Tianjin HSR had transported over 18.7 million passengers (Qi and Wang, 2009).

3.2. Research design, unit of analysis

We used a revised Wilson Model (Li et al., 2012), described as Tourism Spatial Interaction (TSI) to measure the tourism spatial interaction between Beijing and Tianjin over the period 2002 to 2017. We applied the first derivative of the TSI versus different factors to compare the impact of a range of factors including population, destination attractiveness, disposable income and income elasticity on tourism spatial interaction. The temporal-spatial structure changes are based on tourism mean center (Hobbs and Stoops, 2002) and tourism standard distance (Kim, 2000). The research region is divided into two units, which equate to the areas of the respective local government administrative boundaries. Data from 2000 through to 2017 on tourist numbers and tourism enterprises in each zone were obtained from annual statistic bulletins and reports published by local tourism administrations and the Ministry of Culture and Tourism of China (Formerly China National Tourism Administration). It should be noted that the tourism data for 2003 was skewed by the fall in passenger traffic during the 2003 Severe Acute Respiratory Syndrome crisis and is treated as

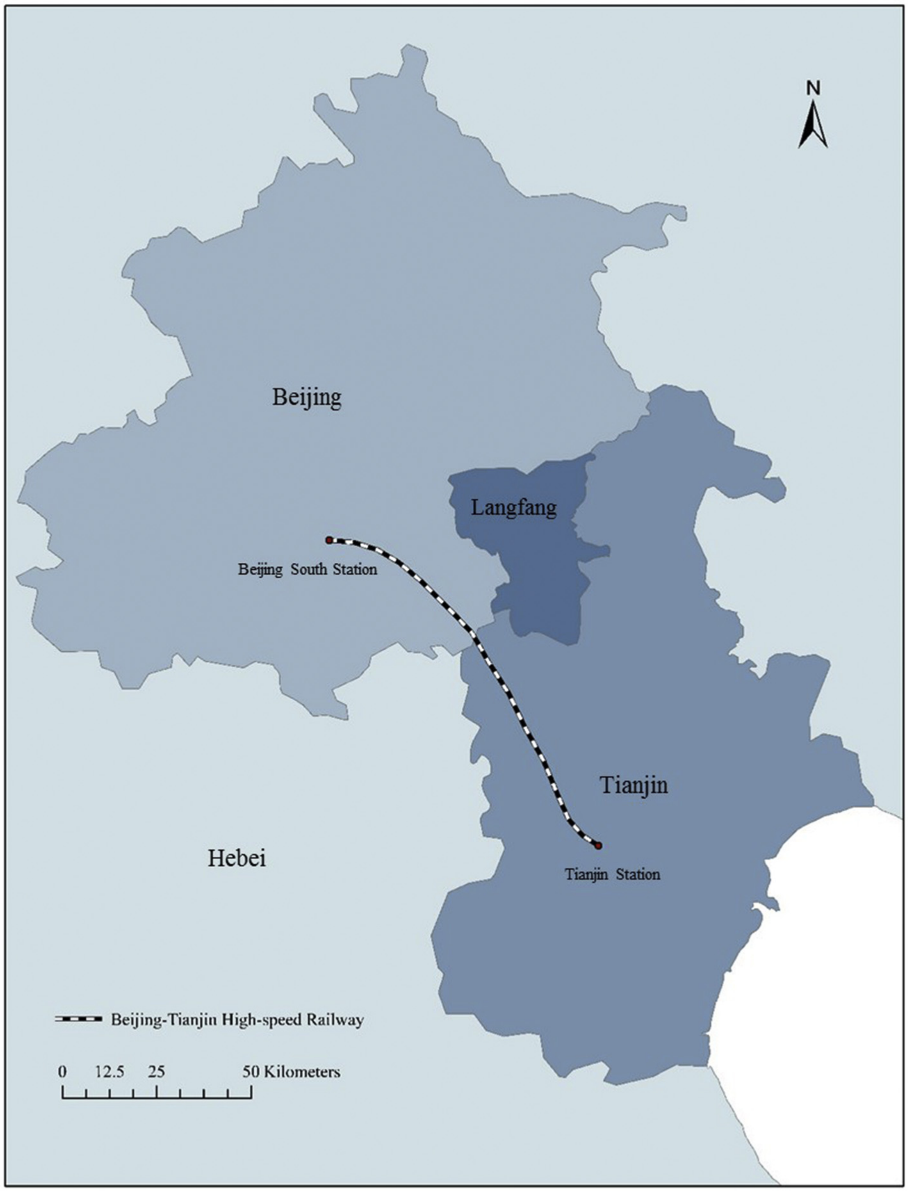

Fig. 1. Beijing-Tianjin HSR.

Table 1
Types of Trains Service between Beijing and Tianjin.

Year	Railway	Type of train	Speed	Travel time
Before 2007	Ordinary railway	Shenzhou	92.8–119.2 km/h	120 min
April of 2007	Ordinary railway	CRH1	200 km/h	69 min
August of 2008	HSR	CRH3/CRH2C	300 km/h	34 min

Table 2
Parameterβ.

Distance (km)	β
< 50	0.05630
< 500	0.0400–0.02724
< 1500	0.03335–0.02094
< 3500	0.03080–0.00186

Table 3
Results of K.

Year	2002	2003	2004	2005	2006	2007	2008	2009
K_T	0.0168	0.0146	0.0142	0.0129	0.0123	0.0291	0.0203	0.0190
K_B	0.1289	0.1105	0.0859	0.0673	0.0680	0.0978	0.0932	0.0754
Year	2010	2011	2012	2013	2014	2015	2016	2017
K_T	0.0172	0.0166	0.0331	0.0315	0.0309	0.0291	0.0300	0.0303
K_B	0.0632	0.0545	0.0812	0.0734	0.0662	0.0626	0.0696	0.0740

Table 4
Results of TSI and derivation of different factors.

Year	TSI_{TB}	TSI_{BT}	$f(A)_{TB}'$	$f(P)_{TB}'$	$f(C)_{TB}'$	$f(r)_{TB}'$	$f(A)_{BT}'$	$f(P)_{BT}'$	$f(C)_{BT}'$	$f(r)_{BT}'$
2002	1.08	1.94	0.01	0.11	0.07	0.04	0.16	0.14	0.10	0.07
2003	1.15	2.13	0.01	0.11	0.07	0.04	0.15*	0.15**	0.10	0.07
2004	1.25	2.35	0.01	0.12	0.07	0.04	0.13	0.16	0.10	0.08
2005	1.35	2.62	0.01	0.13	0.07	0.05	0.11	0.17	0.09*	0.09**
2006	1.59	2.94	0.01	0.15	0.07	0.05	0.13	0.19	0.10	0.09
2007	29.22	39.50	0.19	2.62	1.14	0.98	1.13	2.42	1.15	1.33
2008	87.57	148.73	0.51	7.45	2.89	2.95	3.91	8.77	3.85	5.01
2009	97.40	161.91	0.53	7.93	2.91	3.28	3.44	9.23	3.88	5.46
2010	111.65	190.96	0.55	8.59	2.94	3.76	3.41	9.73	4.20	6.44
2011	124.31	212.67	0.59	9.18	2.96	4.19	3.27	10.54	4.14	7.17
2012	263.74	453.68	1.30	18.66	5.70	8.89	5.34	21.92	7.96	15.29
2013	292.44	494.43	1.37	19.86	5.73	9.86	5.26	23.38	7.85	16.66
2014	299.97	539.92	1.36	19.78	6.09	10.11	5.09	25.09	7.87	18.20
2015	321.82	580.13	1.37	20.80	6.04	10.85	5.18	26.73	7.66	19.55
2016	347.69	649.20	1.42	22.26	6.53	11.72	6.07	29.88	7.91	21.88
2017	380.51	714.97	1.52	24.44	6.56	12.82	6.81	32.94	8.00	24.09

Actual number of 0.15* is 0.152, actual number of 0.15** is 0.146.
Actual number of 0.09* is 0.095, actual number of 0.09** is 0.088.

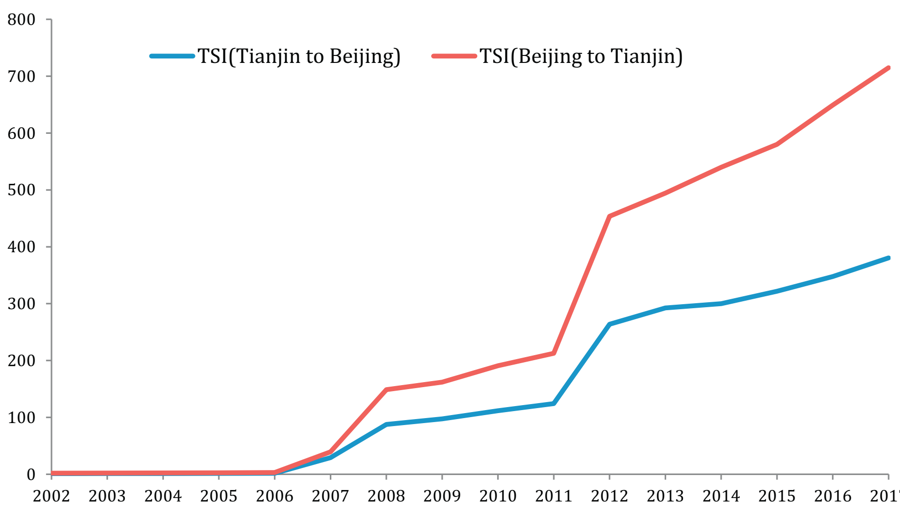

Fig. 2. TSIs between Beijing and Tianjin from 2002 to 2017.

unordinary data.

3.2.1. Tourism Spatial Interaction (TSI)

A spatial interaction is a realized movement of people, freight or information between an origin and a destination (Rodrigue et al., 2016). TSI is a key representation of the level of tourism industry development level between tourism origin and destination and is described in gravity models (Haynes and Fotheringham, 1984; Lowe and Moryadas, 1975; Roy and Thill, 2004; Sen and Smith, 2012). Gravity models are often used to explain bilateral tourism movements between two geographic areas (Morley et al., 2014). Empirical support focusing on international tourism can be found in tourism flow analysis (Keum, 2010; Khadaroo and Seetanah, 2008) although some inherent defects in the model are still present (Olsson, 1967). Wilson's model (Wilson, 1967, 1970) with exponential deterrence function becomes a possible alternative. Li et al. (2012) presented a revised Wilson's model with three important coefficients basing on traditional regression method based on data from China. The models are:

$$T_{jk} = KA_k P_j C_j^{\alpha} exp(-\beta r_{jk}) \quad (1)$$

Where $T_{jk}$is the tourism spatial interaction between origin $j$and destination k ; A_k presents the attractiveness of destination k; $P_j C_j^{\alpha}$is the tourism demand capacity for destination k from origin j, where P_j is the amount of population and C_j is the average disposable income in origin j; r_{jk} is the distance between j and k; α is the income elasticity index, indicating the degree of change in the amount of demand caused by changes in income ; β is the coefficient of spatial damping, which determines the influence of distance on spatial interaction; K is a balancing factor.

Li et al. (2012) evaluated K, α and β. α, understood as income elasticity, was estimated using the traditional regression method, and the result is 0.64. β was estimated using "integral method on tourist amount" (IMTA) (Li et al., 2012), and the result is shown in Table 2.

Given that the distance between Beijing and Tianjin is about 150 km (which is < 500 km), β might be a number between 0.04 and 0.02724. Since the purpose of this paper is to estimate the TSIs between the two cities and to judge the trend of TSIs change from the perspective of time, the average of 0.04 and 0.02724 is placed on β, which is 0.0337.

K was estimated using the data of the whole country from 1999 to 2008 in Li et al. (2012). It is not appropriate to use the number directly given these were calculated from the data for China as a whole. We calculate K basing on the Eq. (2):

$$K_j = \left[\sum_k A_k exp(-\beta r_{jk}) \right]^{-1} \quad (2)$$

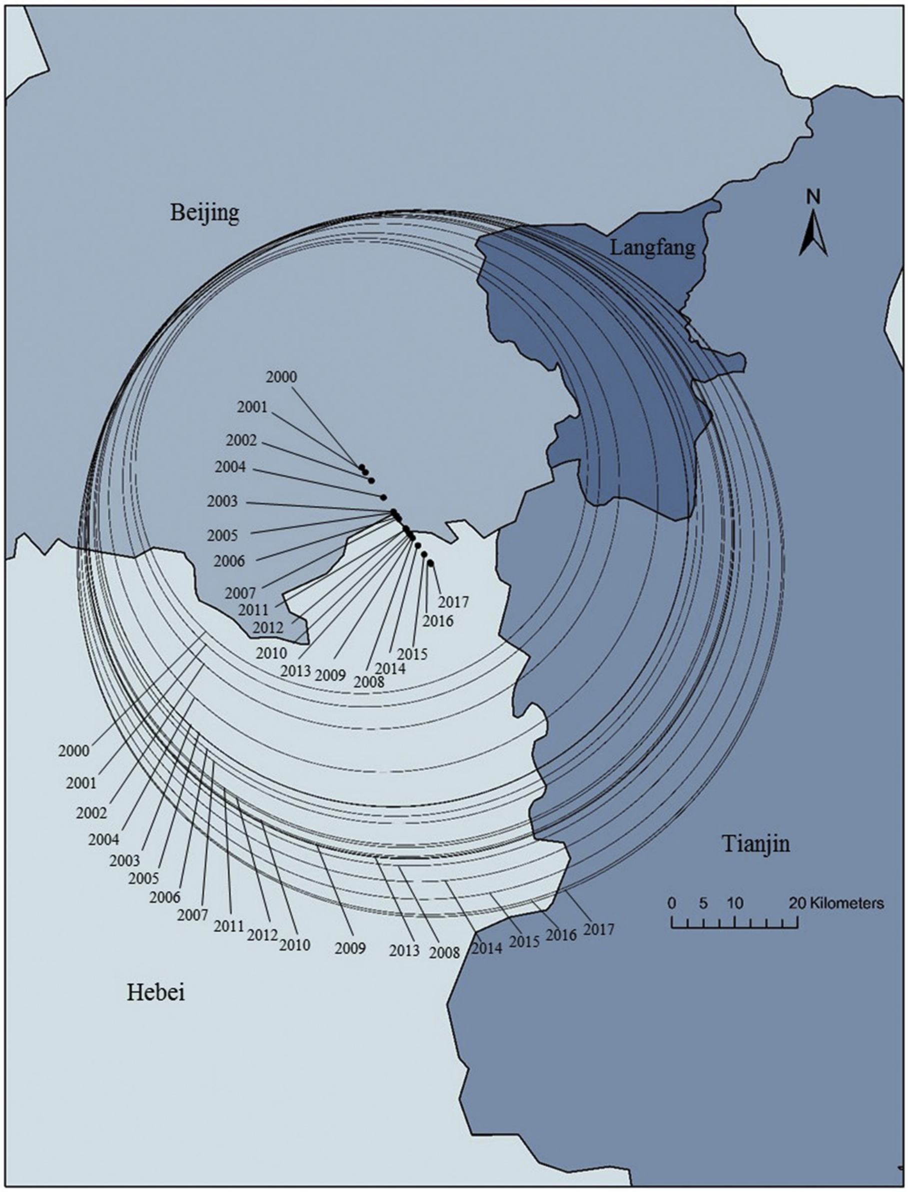

Fig. 3. Domestic tourists mean centers from 2000 to 2017.

The results of K is shown in Table 3.

The equation for TSI between Beijing and Tianjin is shown as following:

$$T_{jk} = K_j A_k P_j C_j^{0.64} exp(-0.0337 r_{jk}) \quad (3)$$

In China, the quality of a tourist scenic spot (or tourist attraction) is rated using a coding system (AAAAA, AAAA, AAA, AA, and A) with five As designating the highest quality scenic spot. We use the number of A-level scenic spots as the measure of A_k. Population size, disposable income and A-level Scenic Spots are published in the Annual Statistical Bulletin of Economic and Social Development for each city. The shortest travel time is chosen as the measure of distance between j and k , since the physical distance is replaced by temporal distance because of the advancement of transportation technology (Wang et al., 2014a) and 'the shrinking continent' effect described by (Spiekermann and Wegener, 2008).

The method of derivation is introduced to compare the impact derived from different variables of spatial interaction. The more absolute the value of the derivative is, the higher impact is derived from that variable. Derivation is expressed as follows:

$$\begin{aligned} f(A)' &= KP_j C_j^{\alpha} e^{-\beta r_{jk}} \\ f(P_j)' &= KA_k C_j^{\alpha} e^{-\beta r_{jk}} \\ f(C_j)' &= KA_k P_j C_j^{\alpha} e^{-\beta r_{jk}} \alpha C_j^{\alpha-1} \\ f(r_{jk})' &= KA_k P_j C_j^{\alpha} e^{-\beta r_{jk}} (-\beta) \end{aligned} \quad (4)$$

3.2.2. *Tourism mean center and standard distance*

To examine if there are changes in the tourism spatial structure before and after the operation of HSR, tourism mean center and standard distance are used in this paper. Mean center is used to identify the geographic center for a set of features and the U.S. Census Bureau (Hobbs and Stoops, 2002, pp. B-4) defined the indicator as "The point at which an imaginary, flat, weightless, and rigid map of the United States would balance perfectly if weights of identical value were placed on it so that each weight represented the location of one person on the date of the census". The United States Census Bureau uses mean center to measure changes the population in the US (Hobbs and Stoops, 2002).

As Kim (2000) stated 'Standard distance is a measure of spatial dispersion, indicating whether an attribute (e.g. population) is widely

Table 5
Tourism mean center and standard distance in Beijing and Tianjin.

Year	Tourists' type		2000	2001	2002	2003	2004	2005
Mean Center	Domestic	X	116.5426	116.5493	116.5605	116.6023	116.5831	116.6020
		Y	39.6964	39.6893	39.6773	39.6327	39.6532	39.6330
	International	X	116.4629	116.4751	116.4828	116.5346	116.5009	116.5053
		Y	39.7815	39.7685	39.7602	39.7049	39.7410	39.7362
Standard Distance	Domestic		35.9763	37.3052	39.4915	46.9466	43.6598	46.9044
	International		18.9094	21.6225	23.4023	34.3653	27.2695	28.2291
Year	Tourists' type		2006	2007	2008	2009	2010	2011
Mean Center	Domestic	X	116.6075	116.6117	116.6371	116.6324	116.6312	116.6243
		Y	39.6271	39.6227	39.5956	39.6006	39.6018	39.6092
	International	X	116.5162	116.5218	116.5602	116.5685	116.5673	116.5858
		Y	39.7246	39.7186	39.6776	39.6687	39.6701	39.6503
Standard Distance	Domestic		47.7970	48.4532	52.1570	51.5147	51.3563	50.3640
	International		30.5435	31.7132	39.4351	41.0036	40.7708	44.1351
Year	Tourists' type		2012	2013	2014	2015	2016	2017
Mean Center	Domestic	X	116.6259	116.6329	116.6473	116.6591	116.6699	116.6717
		Y	39.6075	39.6001	39.5846	39.5720	39.5605	39.5586
	International	X	116.6157	116.6539	116.6829	116.7034	116.7210	116.7178
		Y	39.6184	39.5776	39.5467	39.6707	39.6708	39.6708
Standard Distance	Domestic		50.5950	51.5850	53.4829	54.8743	56.0203	56.1932
	International		49.0795	54.2812	57.2204	57.4078	57.7568	57.6881

dispersed with a high standard distance or concentrated'. Because standard distance gauges dispersion around the mean center, it is sensitive to extreme cases (Kim, 2000) and is an appropriate tool for describing dispersion patterns where there are only minor changes underway in the periphery of the area under study.

Mean center and stand distance are calculated as follows:

$$x = \sum_{i=1}^{n} p_i x_i \Big/ \sum_{i=1}^{n} p_i$$

$$y = \sum_{i=1}^{n} p_i y_i \Big/ \sum_{i=1}^{n} p_i \quad (5)$$

$$D = R \times \sqrt{\frac{\sum_{i=1}^{n} \left(p_i / \sum_{i=1}^{n} p_i\right)^2 [(y_i - y)^2 + (x_i - x)^2]}{\sum_{i=1}^{n} \left(p_i / \sum_{i=1}^{n} p_i\right)^2}} \quad (6)$$

where, (x, y) represents the tourism mean center, D is the standard distance. P_i is the amount of tourists of the tourism unit i , and (x_i, y_i) is the geographical coordinates of the unit i. R is a constant term to convert the spherical distance to the plane distance which is 111.32.

In this paper, we use the coordinates of the HSR stations as the coordinate for Beijing and Tianjin separately, which are (116.38,39.87) for Beijing South Railway Station and (117.12,39.08) for Tianjin Railway Station. R can be found in the Annual Statistic Bulletin of Economic and Social Development of each city. Geographic Information System Mapping package Arcgis 10.3 is used for processing of data and illustrating results.

4. Findings

4.1. TSIs between Beijing and Tianjin and the influence from different factors

The tourism spatial interactions between Beijing and Tianjin were examined according to formula (3) and (4) and presented in Table 4 and Fig. 2. Two major findings can be observed from these results.

First, TSIs between Beijing and Tianjin have increased greatly over the period of the study and can be attributed to growth in population and disposable income, increased tourist attractions, but most importantly to decreased travel time. The TSI between Beijing to Tianjin is larger than that between Tianjin to Beijing indicating that Beijing is more attractive to Tianjin than the other way round.

Second, the growth of TSIs from 2002 to 2017 can be grouped into three stages. During stage one (2002 to 2006), the curve was quite steady, suggesting that there is little increase of TSIs. Stage 2 occurred between 2007 and 2008 when the TSIs increased dramatically. As previously mentioned, the travel time between Beijing and Tianjin decreased from 120 min to 69 min in 2007 and to 34 min in 2008. We can also observed the correspondingly increases of TSIs in 2007 and 2008 in both directions. After 2008, the growth of TSIs continued at high but different rates. The reduction in travel times led to an increase in K in the TSI equation and in turn lead to increases in TSIs.

The impact of input factors on the spatial effect is shown in Table 4. From the size of the impact of these factors, we can determine the impact of HSR services on the spatial effects of the two cities.

The results show that the impact of travel time brought about by HSR on TSIs has been the most dramatic. Travel time was the least important factor on TSIs from Beijing to Tianjin before 2005 and its importance was only higher than disposable income in 2006 and 2007 but become the most important factor after 2008.

4.2. Changes in domestic tourists flows' spatial structure

Analysis of the spatial changes in domestic tourist movements between Beijing and Tianjin using mean center and standard distance revealed that there have been three distinct periods of changes in tourist spatial structure between 2000 and 2017. The first period from 2000 to 2008 (see Fig. 3) represents the period prior to the opening of the HSR service. During this period, the domestic tourism mean center moved southeastwards towards Tianjin. This occurred because of the "pull" exerted by tourism development in Tianjin and the "push" exerted by the emissiveness in Beijing. The standard distance from the mean center increased from 35.98 in 2000 to 52.16 in 2008, indicating greater tourist dispersion (see Table 5). The dispersion is shown in (Fig. 3).

In the second period from 2009 to 2011, the tourism mean center moved north-west towards Beijing (see Fig. 3). The standard distance away from the mean center declined from 52.16 in 2008 to 50.36in 2011, indicating that tourists began to concentrate in Beijing after 2008. While the 2008 Olympic Games and post-games interest in visiting Olympic sites were likely to be significant factors behind the change of tourist flows spatial structure, the operation of HSR should not be ignored.

In the third period (2012-2017), the tourism mean center along the Jingjin HSR line reversed as it moved back towards Tianjin (see Fig. 3). In this period, the standard distance from the mean center increased from 50.59 in 2012 to 56.19 in 2017. The change in both mean center

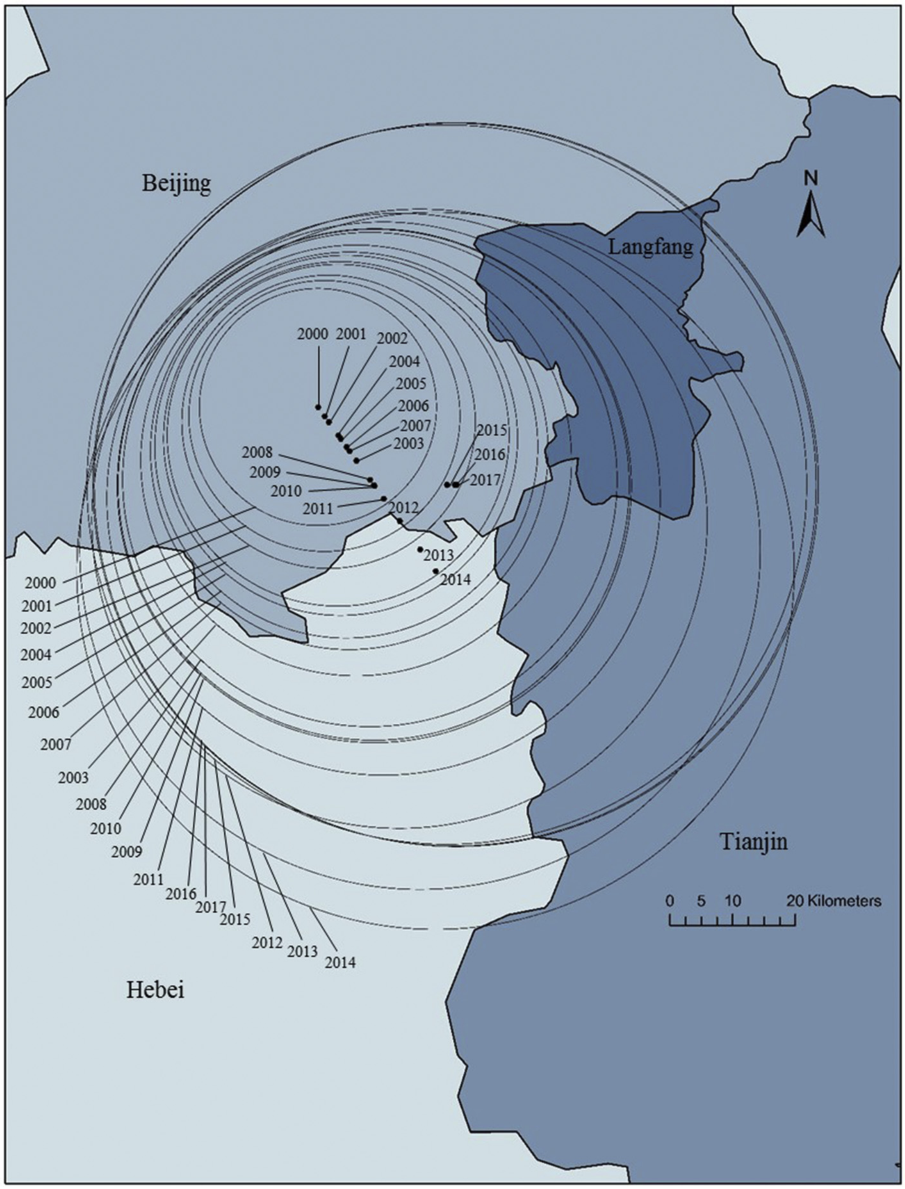

Fig. 4. International tourists mean centers from 2000 to 2017.

and standard distance is illustrated by the shift in tourist activities and dispersion towards Tianjin during 2012 to 2017.

4.3. Changes in international tourists' flows' spatial structure

In the case of international tourists, with the exception of 2003 and 2010, the mean center moved towards Tianjin from 2000 to 2014 and from 2015 to 2017 (see Fig. 4). The standard distance continued to increase during this period, suggesting the emergence of a more pronounced pattern of international tourist's dispersion. The dispersion is shown in Fig. 4.

4.4. The difference between domestic and the international spatial structures

The pattern of distribution of international tourists over the study period is different to that exhibited by domestic tourists with the mean center of domestic tourist distribution being closer to Beijing compared to the mean center of international tourists. This pattern suggests that international tourists have a higher propensity to undertake a one-day trip to Tianjin when visiting Beijing. Domestic tourists also began concentrating back to Beijing after the opening of the HSR service and diffused to Tianjin as additional HSR services were introduced. The results indicate that the spatial structure of international tourist in relation to travel to Tianjin remain the same with or without HSR services.

5. Discussion and conclusions

The objective of this study was to examine how HSR influence tourist flows and spatial relationships between two linked city destinations. The findings indicate dynamic patterns of spatial interaction of the two adjoining cities, which has to date not been investigated the transport geography literature.

The findings of this study advance our understanding of the impact that changes in time-space will have on the tourism spatial interactions of two adjoining metropolitan cities. The change brought about by HSR can have a strong impact on the tourism industry in comparison with other input factors, such as disposable income and tourist attractions which have weakened impact on TSIs.

We found that domestic and international tourists exhibited different distribution patterns. The mean center of domestic tourist's distribution was closer to Beijing than that of international tourists. Domestic tourists initially concentrated in Beijing after the opening of HSR services but became more interested in Tianjin after more frequent HSR services were added. This is a new finding that has not been previously reported. In contrast, the spatial structure of international tourist has continued to move towards Tianjin with or without HSR, which is consistent with the findings by Chen and Haynes (2015) and Pagliara et al. (2015) that intercontinental tourists are less likely to be affected by HSR operations.

The study's findings further support Hannam et al.' (2014) argument that the impact of new mobility capabilities such as the HSR can assist in the creation of new tourism infrastructure such as hotels and leisure complexes. Our study shows that the initial decline in domestic tourism numbers from Beijing spurred the Tianjin tourism authorities to develop new attractions to regain the market share that was lost between 2008 and 2011. It also suggests that it is possible to counter the centralizing effect as suggested by Plassard (1991) by either developing new marketing strategies or new infrastructure development, or both.

There were both similarities and differences of the impacts of HSR in Europe and in China. For example, the relationship between the opening of the HSR and the change in the location of the mean center appears to be an example of the operation of the “structuring effect” where firms, in this case Beijing's tourism sector, were able to take advantage of the change and boost business. It is also apparent that in the post 2008 period there was a change in the intensity of competition which in turn influenced the location of tourism firms. This change highlights how the intensity of competition between connected destinations may increase because of the agglomeration effect as described by Masson and Petiot (2009) and Yan et al. (2014).

The findings of this study also indicate that changes in passenger flows may be reversed if cities develop new or refreshed products and mount successful marketing campaigns. Unlike some of their French counterparts (Gimpel, 1993), neither Beijing nor Tianjin accepted that the changes caused by the HSR were irrevocable and both cities mounted marketing campaigns, and in some cases constructed new infrastructure, to defend their positions.

This research considered the HSR connection between Beijing and Tianjin. Not all factors that may influence the changes of tourism spatial structures between the two adjoining metropolitan cities were analyzed including the effect of expressways linking Beijing and Tianjin and the impact of HSR services in wider region. Other factors not considered include the influence of improvements to the region's entire transportation network and tourism marketing efforts by competing destinations. There is an opportunity to investigate these factors in future research. Moreover, there is also considerable scope to further investigate the effect of time/space compression noted by Plassard (1991) and to build new understandings of the boost that can accrue to local economies.

The latest expansion of the HSR network in the larger Jingjinji Area (Beijing, Tianjin and Hebei Province) provides an additional opportunity to examine the impact of HSR on tourism mobility within the larger region. The expanded HSR network will connect all cities in the Jingjinji Area and is likely to have a huge influence on tourists' motivation, the location of tourism enterprises and tourism spatial structure.

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